

What is claimed is:

1. A roll-over valve for a blow-by gas circulation system of an engine, the roll-over valve comprising:

a valve housing having an inner chamber that defines an axis, an inlet opening disposed in a lateral side of the valve housing, and an outlet opening disposed in the valve housing; and

a piston slidably disposed in the inner chamber for movement relative to the valve housing along the axis, the piston having normal and roll-over positions relative to the valve housing, wherein the inlet and outlet openings fluidly connect to each other via the inner chamber when the piston is in the normal position, wherein the piston slides from its normal position to its roll-over position under the force of gravity when the valve rolls into an overturned position, and wherein the piston blocks at least one of the inlet and outlet openings to prevent fluid flow through the inner chamber when the piston is in its roll-over position.

2. The roll-over valve of claim 1, further comprising a blow-off valve fluidly connecting the inlet and outlet openings, wherein the blow-off valve opens when a pressure in the inlet opening exceeds a predetermined pressure relative to a pressure in the outlet opening.

3. The roll-over valve of claim 2, wherein the blow-off valve closes when the pressure in the inlet opening falls below the predetermined pressure.

4. The roll-over valve of claim 1, further comprising an air-bleed passage that fluidly connects portions of the inner chamber that are disposed on opposing axial sides of the piston.

5. The roll-over valve of claim 4, wherein the air-bleed passage has first and second opposing ends, wherein the first end of the air-bleed passage fluidly connects to a bottom axial portion of the inner chamber such that the first end aligns with the axis, and wherein the second end fluidly connects to the outlet opening.

6. The roll-over valve of claim 4, wherein the air-bleed passage comprises an axially extending bore in the piston.

7. The roll-over valve of claim 6, further comprising an inner piston slidably disposed in the bore, wherein the inner piston has normal and roll-over positions relative to the piston, and wherein the inner piston blocks the air-bleed passage when the inner piston is in its roll-over position.

8. The roll-over valve of claim 7, wherein the inner piston has a guiding portion that has a polygonal cross-section that guides the inner piston along the axis of the bore.

9. The roll-over valve of claim 8, wherein the inner piston has a guiding portion that has a cross-sectional area that is at least 85% of a cross-sectional area of the surrounding bore.

10. The roll-over valve of claim 7, wherein the inner piston has a frusto-conical upper surface, and wherein an upper portion of the bore has a reduced diameter frusto-conical surface that seals against the frusto-conical upper surface of the inner piston when the inner piston moves into its roll-over position.

11. The roll-over valve of claim 1, wherein the inlet opening connects to the inner chamber at a position where any pressure that develops in the inlet opening does not urge the piston into the roll-over position.

12. The roll-over valve of claim 1, wherein the outlet opening is disposed at an upper axial end of the inner chamber.

13. The roll-over valve of claim 1, wherein an upper portion of the piston has a frusto-conical surface.

14. The roll-over valve of claim 13, wherein the outlet opening has a frusto-conical surface that seals against the frusto-conical surface of the piston when the piston is in the roll-over position.

15. The roll-over valve of claim 1 in combination with a blow-by gas circulation system comprising:

an oil tank having

an inlet adapted to accept blow-by gas from an engine, and

an upper portion that is adapted to be above an oil level in the oil tank when the oil tank is upright;

an oil separator having an inlet adapted to accept blow-by gas, and an outlet adapted to direct blow-by gas to an intake system of the engine; and

a blow-by gas line fluidly connecting the upper portion of the oil tank to the inlet of the oil separator,

wherein the roll-over valve is disposed in the blow-by gas line such that the inlet opening fluidly connects to the upper portion of the oil tank and the outlet opening fluidly connects to the inlet of the oil separator.

16. A blow-by gas system comprising:

an oil tank having

an inlet adapted to accept blow-by gas from an engine,

an upper portion that is adapted to be above an oil level in the oil tank when the oil tank is upright, and

a lower portion that is adapted to be above the oil level in the oil tank when the oil tank is overturned;

an oil separator having an inlet adapted to accept blow-by gas, and an outlet adapted to direct blow-by gas to an intake system of the engine;

a first blow-by gas line fluidly connecting the upper portion of the oil tank to the inlet of the oil separator;

a roll-over valve comprising a first valve portion that is disposed in the first blow-by gas line, wherein the roll-over valve has upright and overturned positions, wherein the first valve portion opens the first blow-by gas line when the roll-over valve is in the upright position, and wherein the first valve portion closes the first blow-by gas line when the roll-over valve is in the overturned position; and

a second blow-by gas line fluidly connecting the lower portion of the oil tank to the inlet of the oil separator.

17. The blow-by gas system of claim 16, wherein the first and second blow-by gas lines converge into a common blow-by gas line before reaching the inlet of the oil separator.

18. The blow-by gas system of claim 16, wherein the roll-over valve further comprises a second valve portion that is disposed in the second blow-by gas line, wherein the second valve portion closes the second blow-by gas line when the roll-over valve is in the upright position, and wherein the second valve portion opens the second blow-by gas line when the roll-over valve is in the overturned position.

19. The blow-by gas system of claim 18, further comprising an oil return line fluidly connecting the lower portion of the oil tank to the oil separator, wherein the roll-over valve further comprises a third valve portion that is disposed in the oil return line, wherein the third valve portion opens the oil return line when the roll-over valve is in the upright position, and wherein the third valve portion closes the oil return line when the roll-over valve is in the overturned position.

20. The blow-by gas system of claim 16, wherein the roll-over valve comprises:
a valve housing having an inner chamber and an axis, and
a piston slidably disposed within the inner chamber,

wherein the piston is disposed in a normal position when the roll-over valve is in the upright position, and wherein the piston moves into a roll-over position when the roll-over valve is in the overturned position.

21. The blow-by gas system of claim 20, wherein the first valve portion comprises a first groove in the piston that aligns with opposing openings in the first blow-by gas line to permit fluid flow through the first blow-by gas line when the piston is in the normal position, and wherein the first groove misaligns with the opposing openings in the first blow-by gas line when the piston is in the roll-over position such that the piston prevents fluid flow through the first blow-by gas line.

22. The blow-by gas system of claim 21, wherein the roll-over valve further comprises a second valve portion that is disposed in the second blow-by gas line, the second valve portion comprising a second groove in the piston, the second groove aligning with opposing openings in the second blow-by gas line to allow fluid flow through the second blow-by gas line when the piston is in the roll-over position, the second groove misaligning with the opposing openings in the second blow-by gas line when the piston is in the normal position such that the piston prevents fluid flow through the second blow-by gas line.

23. The blow-by gas system of claim 22, further comprising an oil return line fluidly connecting the lower portion of the oil tank to the oil separator, wherein:

the roll-over valve further comprises a third valve portion that is disposed in the oil return line;

the third valve portion comprises a third groove in the piston that aligns with opposing openings of the oil return line to allow fluid to flow through the oil return line when the piston is in the normal position; and

the third groove misaligns with the opposing openings in the oil return line when the piston is in the roll-over position such that the piston prevents fluid flow through the oil return line.

24. The blow-by gas system of claim 21, wherein the piston has an axial bore extending therethrough.

25. The blow-by gas system of claim 24, wherein the piston has a first radial bore fluidly connecting the first groove to the axial bore, and wherein the piston has a second radial bore fluidly connecting the third groove to the axial bore.